Fine Root Standing Crop and Specific Root Length in a CO_2 Enriched Deciduous Forest

Global Change Education Program

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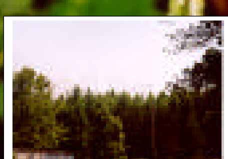
Abstract

Fine root standing crop productivity and specific root length have important roles in the study of both root productivity, as well as net primary productivity. However, fine roots standing crop is difficult to quantify, and new methods are being developed to compensate. For instance, Minirhizotron technology is growing, but some aspects of this new method must be refined. Specific root length(SRL) may not need to be differentiated by treatment, but it does need to be differentiated by size class.

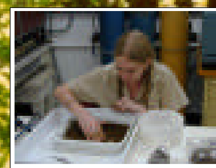
Introduction

- This experiment was conducted in a *Liquidambar styraciflua* plantation in Tennessee, which is a Free-Air CO_2 Enrichment (FACE) Experiment (Norby, et al; 2001).
- The experiment explored the affect of elevated atmospheric CO_2 levels on fine root standing crop mass and specific root length (SRL).
- Fine root standing crop mass has been shown to be important to understanding carbon sequestration within varying ecosystems (Norby, et al; 2002).
- The experiment also investigated the accuracy of data compiled with minirhizotron technology.
- Specific Root Length is an important factor of quantifying fine root productivity with minirhizotron technology, because it is necessary to calculate fine root mass.
- Therefore, the distinction of SRL for each diameter class is also a significant factor concerning root productivity and, overall, net primary productivity (Eissenstat, et al, 2000).



Methods

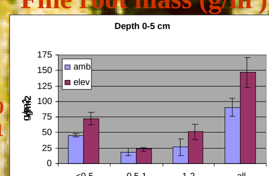
- Five soil core samples were extracted from each of the 5 rings at the FACE site. Each core consisted of 3-5 cm layers: 0-5, 5-10, and 10-15 cm deep.
- Then, the roots were separated from the soil, washed and classified by diameter: 0-0.5,0.5-1.0, 1.0-2.0, and >2.0 mm.
- One representative root from each class size per sample layer was removed, and each was digitized using the minirhizotron. The ROOTS software (Michigan State University Lansing, MI, USA) was used to calculate each root's length.
- The roots were dried in an oven at about 70 degrees Celsius for 2 days.
- The mass of each sample set was found without the representative roots, which were weighed in groups per size class per layer from each ring to decrease error.
- Using the length and mass measurements, the specific root length was calculated and the data was analyzed.

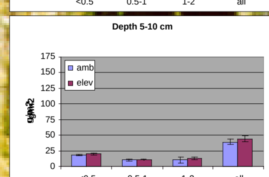


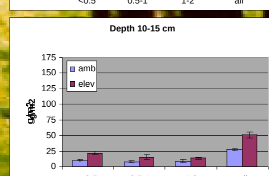
Results

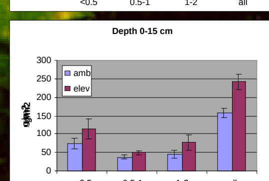
- Fine root mass increased significantly by 54.7% across all size classes and depths, and, of that, 47.3% of the roots was less than 0.5 mm in diameter, which was marginally significant.
- Depth was a highly significant source of variation in root density ($P<0.001$).
- Each depth reacted differently to CO_2-enrichment ($P=0.034$):
  within 0-5 cm depth, CO_2 was marginally significant ($P=0.075$).
  within 5-10 cm depth, CO_2 was not significant; and
  within 10-15 cm depth , CO_2 was highly significant ($P<0.001$);
- Over all size classes and depths CO_2 did not have a significant effect on SRL; however, the data suggest a slight increase in all layers.
- Depth was also not a significant source of variation, but SRL varied significantly with size class, and :
  within <0.5 mm size class, $P=0.11$
  within 0.5-1.0 mm size class, $P=0.099$
  within 1.0-2.0 mm size class, $P<0.001$

Fine root mass (g/m^2)

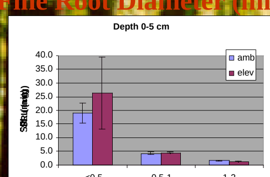


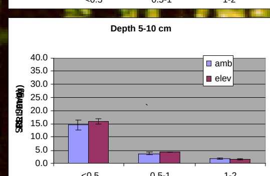


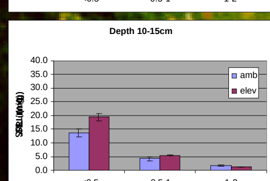




Fine Root Diameter (mm)







Conclusion

- This data supports previous studies on the effects of CO2-enrichment on fine root standing crop and specific root length (SRL)
- In addition, minirhizotron data is comparable to these direct measurements, taking different maximum depths into consideration.
- SRL can also be used to better quantify minirhizotron data by using different SRL for each size class, particularly below 2.0 mm.
- However, in scaling minirhizotron data, differentiation between SRL for each treatment is not necessary, because there was only a small .
- Each depth has a different response to root density and, therefore, should be taken into consideration.
- Size class distribution remained consistant, and the smallest class size represented a substantial fraction of each layer's total mass.

Acknowledgements

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References

Norby, R. J., P. J. Hanson, E. G. O'Neill, T. J. Tschaplinski, J. F. Weltzin, R. T. Hansen, W. Cheng, S. D. Wullschleger, C. A. Gunderson, N. T. Edwards, D. W. Johnson. 2002. Net primary productivity of a $C0_2$-enriched deciduous forest and the implications for carbon storage. *Ecological Applications*, in press.

Norby, R. J., D. E. Todd, J. Fults, and D. W. Johnson. 2001. Allometric determination of tree growth in a CO_2-enriched sweetgum stand. *New Phytologist* 150: 477-487.

Eissenstat, D. M., C. E. Wells, R. D. Yanai, and J. L. Whitbeck. 2000. Building roots in a changing environment: implication for root longevity. *New Phytologist* 147: 33-42.